

Assessment Test

Unit 7 Data structures

Final assessment test

1. A hospital has asked for a program that will control the order in which the arrivals are seen in the accident and emergency department.
 - (a) A priority queue has been chosen to store the arrival information.
 - (i) State the property of a priority queue that makes it suitable for this application. [1]

- (ii) The priority queue is implemented using a circular queue.

State an advantage of a circular queue which makes it more efficient in use of memory. [1]

- (b) A test version of the priority circular queue consists of 5 cells. Arrival information consists of a severity rating and a last name. The severity scale is 3 (least severe), 2 (moderately severe), and 1 (most severe). For example, Mr Jones has a severity rating of 2. His arrival record would be '2 Jones'.

Complete the diagram to show the results after the following operations. [4]

Note: The first element in the queue has an index of 0.

	arrivals					count	front	rear	returned
	[0]	[1]	[2]	[3]	[4]				
	1 Black	1 Singh	2 Jones	3 Reeve		4	0	3	
Dequeue									
Enqueue '3 Mason'									
Enqueue '2 Ing'									
Dequeue									

2. A stack is an important data structure in computer science.

- (a) Define the term stack. [2]

- (b) A call stack is used when subroutines are called.
Name **two** items that may be put on a call stack. [2]

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(c) Explain how a recursive algorithm could cause a system to crash. [2]

(d) State **one** other use of a stack in a computing system. [1]

3. (a) Describe the difference between a dynamic and a static data structure. [2]

(b) Nodes in a linked list consist of a data field and a pointer to the next node:

The linked list is implemented in an array.

(i) Show how the array is initialised with a start pointer and a nextfree pointer.
The list of free nodes is itself a linked list of all the nodes in the empty array. [2]

index	name	pointer
0		1

start =

nextfree =

(ii) Names are added to the linked list in the sequence Charles, Amy, Tasmin, Gerri.

Show the array and pointers after these names have been added. [2]

index	name	pointer

start =

nextfree =

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(iii) The function ListProcess is defined as follows:

```
function ListProcess
  x = 0
  currentPtr = start
  while currentPtr <> null
    x = x + 1
    currentPtr = subjectList[currentPtr].pointer
  endwhile
  print (x)
endfunction
```

(c) (i) Complete the following trace table to show the operation of function ListProcess when it is processes the linked list below. [2]

(ii) What is its purpose? [1]

Trace table:

x	currentptr	OUTPUT

subjectList

Index	subject	pointer
0	Maths	null
1	English	3
2	History	0
3	Geography	2
4		null

start = 1

nextfree = 4

(d) Amend the algorithm so that it prints all the names in the linked list. [1]

4. Hashing is often used when large amounts of data need to be stored.

(a) Explain how a hashing algorithm works. [3]

(b) A particular hashing algorithm sums all the individual digits in a number and takes the remainder after division by 11 as the address in the hash table. Apply this algorithm to 7823901. [1]

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- (c) In the following hash table, collision resolution is done by storing the item in the next free slot.

[0]	
[1]	
[2]	Jones
[3]	Wilson
[4]	Smith
[5]	Brown
[6]	
[7]	
[8]	Green
[9]	
[10]	Gold

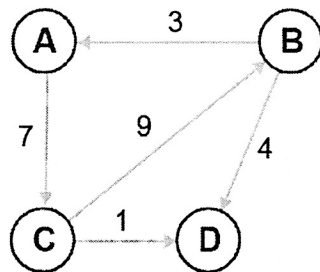
- (i) The value "Redmond" needs to be added to the table. The hash value is 6.
State the value of the table index where "Redmond" is stored. [1]
- (ii) The value "Farmer" needs to be added to the table. The hash value is 10.
State the value of the table index where "Farmer" is stored. [1]
- (d) The performance of a particular large hash table has degraded as the table fills up.
- (i) Explain why this might be the case. [1]
- (ii) Explain **one** possible way of improving the performance of the hash table. [2]
5. Towns and the connections between them can be represented as a graph which has a set of nodes connected by edges. This representation is an abstraction.
- (a) Define the term data abstraction. [2]

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(b) Complete the adjacency list for this graph.

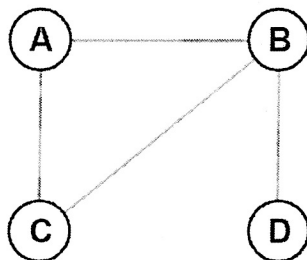
[2]



A	→	{C:7}
B	→	
C	→	
D	→	

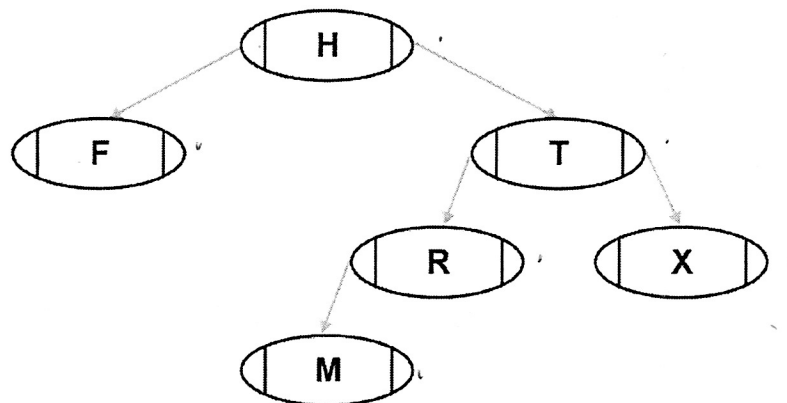
(c) Complete the adjacency matrix for this graph.

[2]



	A	B	C	D
A				
B				
C				
D				

6. (a) Here is a binary tree.



Complete the array implementation of this tree.

[2]

	left	data	right
A[0]	3	H	1
A[1]			
A[2]	5	R	-1
A[3]	-1	F	-1
A[4]	-1	X	-1
A[5]			

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- (ii) List the nodes in the order in which they are visited for each traversal. [3]

Pre-order:

In-order:

Post-order:

- (c) Add the following items to a binary tree so that it may be quickly searched to find a particular item:

Liam, Mary, Zoe, Carla, David, Lucy, Adam

[2]

- (d) Write a pseudocode for a recursive procedure to output the names in post-order traversal of the tree. [5]

The first line of the procedure is given below.

```
procedure postOrderTraverse (root)
```

[Total 50 marks]